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Dated 8 January 2004

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# Request for grant of a patent

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The Patent Office

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1. Your reference SMC 60564/GB/P1
2. Patent application number  
(The Patent Office will fill in this part) 04 JAN 2003 0300225.0
3. Full name, address and postcode of the or of each applicant (underline all surnames)  
  
NeoResins Inc  
730 Main Street  
Wilmington MA 01887  
USA  
  
Patents ADP number (if you know it) 08537763001  
  
If the applicant is a corporate body, give the country/state of its incorporation  
USA, DELAWARE
4. Title of the invention  
Aqueous Polyurethane Coating Composition
5. Name of your agent (if you have one)  
  
SCHMITT, Maja  
  
"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)  
  
Avecia Limited  
Hexagon House  
Blackley  
Manchester, M9 8ZS  
United Kingdom  
  
Patents ADP number (if you know it) 7742125001
6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number  

Country	Priority application number (if you know it)	Date of filing (day / month / year)
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7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application  

Number of earlier application	Date of filing (day / month / year)
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8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if:  
a) any applicant named in part 3 is not an inventor, or  
b) there is an inventor who is not named as an applicant, or  
c) any named applicant is a corporate body.  
See note (d))

# Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form

Description

15

Claim(s)

3

Abstract

Drawing(s)

10. If you are also filing any of the following, state how many against each item.

Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

Request for preliminary examination and search (Patents Form 9/77)

1

Request for substantive examination (Patents Form 10/77)

Any other documents (please specify)

11. I/We request the grant of a patent on the basis of this application.

Signature K. M. Pinder Date 2/1/03  
NeoResins Inc, Authorised Signatory 02/01/03

12. Name and daytime telephone number of person to contact in the United Kingdom

Mrs K.M. Pinder/Miss G. Terry 0161 721 1361/2

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Aqueous Polyurethane Coating Composition

The present invention relates to an aqueous coating composition having a 60° gloss of  $\leq 40$  upon drying, a process for preparing such a composition and a coating obtained from such a composition.

5 Coating compositions have long been used to produce coatings having desired coating characteristics. For example coating compositions are used to protect surfaces from the environment, to conceal surface irregularities, to provide a surface which is more receptive to further treatment, or to enhance the surface appearance, such as providing high loss or low gloss.

10 Gloss is associated with the capacity of a surface to reflect more light in some directions than in others. High gloss surfaces reflect a high proportion of light directed at them and low gloss surfaces reflect a low proportion of light directed at them. The directions associated with mirror (or specular) reflection normally have the highest reflectances. Measurements by such a test method (as described for example in ASTM D 523-89 correlate with visual observations of surface shininess made at roughly the  
15 corresponding angles. Low gloss coatings that produce less image impairment are often more pleasing aesthetically.

Traditionally low gloss coating compositions are obtained by the addition of flattening agents such as silicone dioxide. Flattening agents are well known in the art and  
20 traditionally comprise materials ground into minute particles of irregular shape which are used in compositions such as paints and varnishes to disperse incident light rays so that a low gloss effect is achieved. Standard flattening agents include but are not limited to silica, diatomaceous earth, heavy metal soaps, talcum and chalk. To obtain for example low gloss in clear coats, typically more than 6 wt.% of flattening agent based on the weight  
25 of the coating composition has to be added.

The disadvantages resulting from the addition of flattening agents to reduce gloss include coagulation of the composition resulting in a seedy appearance; increased brittleness of the resultant coating; settling out of the flattening agents often resulting in inconsistent mixing before application resulting in variation in gloss throughout the  
30 coating; and a decrease in burnish resistance as well as reducing the general resistance and performance properties of the coating. Burnish is the change in appearance of a coating as a result of rubbing the coating with a different material. The change in appearance may be measured as a change in the gloss level of a coating.

Low gloss coating compositions have been described in for example US 6,331,582  
35 B1 which discloses a thermally activated coating composition comprising an acrylic or polyester solvent based binder resin, colorant and a polyvinyl acetal matting agent. EP 0841992 A2 discloses a low gloss coating composition comprising acrylic polymer particles containing at least one void and pigments. US 6,410,147 discloses a low gloss solvent based crosslinkable coating composition comprising a combination of a polar

polymer, a non-polar polymer and a crosslinking agent. US 5,744,522 discloses a low gloss coating powder composition comprising an acrylic copolymer, an aromatic polyester and a specific isocyanurate curing agent.

These all describe ways of avoiding the use of silicone dioxide flattening agents, however they appear to be providing complex and costly solutions, including a preference for the use of solvents and powders.

~~The aqueous coating composition of the present invention provides a low gloss~~  
coating without the use of flattening agents. Furthermore the coating obtained from the aqueous coating composition of the present invention has a warmer look when compared with a conventional urethane coating using flattening agents. The look is very subjective but may be measurable by colour tones, a cooler look may appear bluer while a warmer look may appear more white.

According to the present invention there is provided an aqueous coating composition having a 60° gloss of  $\leq 40$  upon drying comprising a self-crosslinkable polyurethane obtained by the reaction of:

(A) an isocyanate-terminated pre-polymer formed from components which comprise

- (i) 5 to 65 wt% of at least one organic polyisocyanate;
  - (ii) 0.1 to 6 wt% of at least one polyol containing ionic or potentially ionic water-dispersing groups, having two or more isocyanate-reactive groups and having a molecular weight in the range of from 100 up to 500 g/mol;
  - (iii) 0 to 30 wt% of at least one polyol containing water-dispersing groups, having two or more isocyanate-reactive groups and having a molecular weight in the range of from 500 to 6000 g/mol;
  - (iv) 10 to 80 wt% of at least one polyol containing crosslinkable groups, having two or more isocyanate-reactive groups and having a molecular weight in the range of from 150 to 6000 g/mol;
  - (v) 10 to 70 wt% of at least one polyol not comprised by (ii) or (iii) having two or more isocyanate-reactive groups and having a molecular weight in the range of from 500 to 6000 g/mol;
  - (vi) 0 to 50 wt% of at least one component not comprised by (i), (ii), (iii), (iv) or (v);
- where (i), (ii), (iii), (iv), (v) and (vi) add up to 100 wt%; and  
where the NCO:OH ratio is in the range of from 1.2 : 1.0 to 10.0 : 1.0; and

(B) at least one active-hydrogen chain extending compound.

Gloss measurements are made with 60°, 20° or 85° geometry of angles and apertures. The 60° geometry is used for comparing most samples and for determining when the 20° geometry may be more applicable. The 20° geometry is advantageous for comparing samples having a 60° gloss value higher than 70. The 85° geometry is advantageous for comparing samples having 60° gloss values lower than 10.

Preferably the 60° gloss of the aqueous coating composition of the invention upon drying is  $\leq 30$ , more preferably  $\leq 20$ , most preferably  $\leq 10$ , especially  $\leq 5$ , and most especially  $\leq 3$ .

Preferably the 85° gloss of the aqueous coating composition of the invention upon drying is  $\leq 60$ , more preferably  $\leq 40$ , more preferably  $\leq 30$ , especially  $\leq 20$ , and most especially  $\leq 10$ .

~~The self-crosslinkable polyurethane is crosslinkable without the requirement for~~  
added compounds which react with groups on the polyurethane to achieve crosslinking, although these can still be employed if desired.

The self-crosslinkable polyurethane may crosslink at ambient temperature by a number of mechanisms including but not limited to autoxidation, Schiff base crosslinking and silane condensation. By crosslinking by autoxidation is meant that crosslinking results from an oxidation occurring in the presence of air and usually involves a free radical mechanism and is preferably metal-catalysed resulting in covalent crosslinks.

Suitably autoxidation is provided for example by fatty acid groups containing unsaturated bonds (by which is meant the residue of such fatty acids which have become incorporated into the polyurethane by reaction at their carboxylic acid groups) or by (meth)allyl functional residues,  $\beta$ -keto ester groups or  $\beta$ -keto amine groups. Preferably autoxidation is provided at least by fatty acid groups containing unsaturated bonds.

By Schiff base crosslinking is meant that crosslinking takes place by the reaction of a carbonyl functional group(s), whereby a carbonyl functional group herein is meant an aldo or keto group and includes an enolic carbonyl group such as is found in an acetoacetyl group with a carbonyl-reactive amine and/or hydrazine (or blocked amine and/or blocked hydrazine) functional group.

By silane condensation is meant the reaction of alkoxy silane or  $-\text{SiOH}$  groups in the presence of water, to give siloxane bonds by the elimination of water and/or alkanols (for example methanol) during the drying of the aqueous coating composition.

Other crosslinking mechanisms known in the art include those provided by the reaction of epoxy groups with amino, carboxylic acid or mercapto groups, the reaction of mercapto groups with ethylenically unsaturated groups such as fumarate and acryloyl groups, the reaction of masked epoxy groups with amino or mercapto groups, the reaction of isothiocyanates with amines, alcohols or hydrazines, the reaction of amines (for example ethylenediamine or multifunctional amine terminated polyalkylene oxides) with  $\beta$ -diketo (for example acetoacetoxy or acetoamide) groups to form enamines. The use of blocked crosslinking groups, such as blocked isocyanate groups, may be beneficial.

Preferably the self-crosslinking is by autoxidation of unsaturated functional groups, such as conjugated unsaturated functional groups, and Schiff base crosslinking optionally in combination with other crosslinking mechanisms as discussed herein.

Methods for preparing polyurethanes are known in the art and are described in for example the Polyurethane Handbook 2<sup>nd</sup> Edition, a Carl Hanser publication, 1994, by G.

Oertel; and these methods are included herein by reference. The self-crosslinkable polyurethane may be prepared in a conventional manner by reacting at least one organic polyisocyanate with at least one isocyanate-reactive compound by methods well known in the prior art. Isocyanate-reactive groups include  $-OH$ ,  $-SH$ ,  $-NH-$ , and  $-NH_2$ . Usually an isocyanate-terminated polyurethane prepolymer is first formed which is then chain extended with an active hydrogen containing compound.

Component (i) comprises any suitable organic polyisocyanates including aliphatic, cycloaliphatic, araliphatic and/or aromatic polyisocyanates. Examples of suitable polyisocyanates include ethylene diisocyanate, 1,6-hexamethylene diisocyanate (HDI), isophorone diisocyanate (IPDI), cyclohexane-1, 4-diisocyanate, 4,4'-dicyclohexylmethane diisocyanate (4,4'-H12 MDI), p-xylylene diisocyanate, p-tetramethylxylene diisocyanate (p-TMXDI) (and its meta isomer m-TMXDI), 1,4-phenylene diisocyanate, hydrogenated 2,4-toluene diisocyanate, hydrogenated 2,6-toluene diisocyanate, 4,4'-diphenylmethane diisocyanate (4,4'-MDI), polymethylene polyphenyl polyisocyanates, 2,4'-diphenylmethane diisocyanate, 3(4)-isocyanatomethyl-1-methyl cyclohexyl isocyanate (IMCI) and 1,5-naphthylene diisocyanate. Preferred organic polyisocyanates are IPDI and/or H<sub>12</sub>MDI which provide improved low yellowing and ease of processing of the self-crosslinkable polyurethane. Mixtures of polyisocyanates can be used and also polyisocyanates which have been modified by the introduction of urethane, allophanate, urea, biuret, carbodiimide, uretonimine, urethdione or isocyanurate residues.

Preferably component (i) comprises 20 to 60 wt.%, more preferably 30 to 50 wt.% of the isocyanate-terminated prepolymer.

Preferably component (i) comprises organic polyisocyanates with a functionality of 2 (i.e. diisocyanates), however the polyurethane prepolymer may also be formed from additional component (ia) comprising 0 to 20 wt.% of at least one organic polyisocyanate with an isocyanate functionality  $\geq 2.2$ , more preferably in the range of from 2.5 to 4.0.

Preferably component (ia) comprises 3 to 15 wt.%, more preferably 4 to 10 wt.% of the isocyanate-terminated prepolymer.

The effect of component (ia) is to allow a degree of pre-crosslinking in the prepolymer, however too much pre-crosslinking may result in an unacceptable increase in viscosity.

Component (ii) comprises any suitable polyol, preferably diol, containing ionic or potentially ionic water-dispersing groups.

Preferred ionic water-dispersing groups are anionic water-dispersing groups, especially carboxylic, phosphoric and or sulphonic acid groups. Examples of such compounds include carboxyl containing diols and triols, for example dihydroxy alcanoic acids such as 2,2-dimethylol propionic acid (DMPA) or 2,2-dimethylolbutanoic acid (DMBA). The anionic water-dispersing groups are preferably fully or partially in the form of a salt. Conversion to the salt form is optionally effected by neutralisation of the self-crosslinkable polyurethane with a base, preferably during the preparation of the self-

crosslinkable polyurethane and/or during the preparation of the aqueous coating composition of the present invention.

If the anionic water-dispersing groups are neutralised, the base used to neutralise the groups is preferably ammonia, an amine or an inorganic base. Suitable amines include tertiary amines, for example triethylamine or N,N-dimethylethanolamine. Suitable inorganic bases include alkali hydroxides and carbonates, for example lithium hydroxide, sodium hydroxide, or potassium hydroxide. A quaternary ammonium hydroxide, for example  $\text{N}^+(\text{CH}_3)_4(\text{OH})$ , can also be used. Generally a base is used which gives counter ions that may be desired for the composition. For example, preferred counter ions include  $\text{Li}^+$ ,  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{NH}_4^+$  and substituted ammonium salts.

Cationic water dispersible groups can also be used, but are less preferred. Examples include pyridine groups, imidazole groups and or quaternary ammonium groups which may be neutralised or permanently ionised (for example with dimethylsulphate). Preferably component (ii) comprises 0.8 to 4.0 wt.%, more preferably 1.9 to 3.0 wt.% of the isocyanate-terminated prepolymer.

Component (iii) may contain ionic water-dispersing groups as discussed above and may also contain non-ionic water-dispersing groups.

Preferred non-ionic water-dispersing groups are polyalkylene oxide groups, more preferably polyethylene oxide groups. A small segment of the polyethylene oxide group can be replaced by propylene segment(s) and/or butylene oxide segment(s), however the polyethylene oxide group should still contain ethylene oxide as a major component. When the water-dispersible group is polyethylene oxide, preferably the polyethylene oxide group has a molecular weight from 175 to 5000 g/mol, more preferably from 350 to 2200 g/mol, most preferably from 660 to 2200 g/mol.

Examples of such compounds containing non-ionic water-dispersing groups include methoxy polyethylene glycol (MPEG) with molecular weights of for example 550, 750, 1000 and 2000 g/mol. Examples of such compounds containing ionic water-dispersing groups include polyether, polyester and polycarbonate polyols containing carboxylic acid groups. Preferably component (iii) comprises 5 to 25 wt.%, more preferably 8 to 20 wt.% of the isocyanate-terminated prepolymer, when levels of component (ii) are kept to the minimum.

The self-crosslinkable polyurethane preferably contains a sufficient concentration of ionic and or non-ionic water-dispersing groups via components (ii) and (iii) capable of rendering the polyurethane self-water-dispersible (i.e. dispersible in water without the requirement to use added dispersing agents) but the concentration of such groups is preferably not so great that the polyurethane has an unacceptably high water solubility in order to not compromise the water sensitivity of the final coating.

The self-crosslinkable polyurethane preferably has an acid value in the range of from 0.3 to 25.1 mg KOH/g, more preferably in the range of from 0.4 to 16.7 mg KOH/g and most preferably in the range of from 0.5 to 11.7 mg KOH/g.



The acid value of the self-crosslinkable polyurethane may vary considerably depending on the hydrophobicity of the polyurethane and the degree, if any, of pre-crosslinking. Moreover, the strength of the anionic water-dispersing groups or their efficiency as a dispersing and/or stabilising group may also influence the optimal amounts required.

The crosslinkable groups contained in component (iv) may be any as discussed above which allow self-crosslinking, including but not limited to autoxidisable groups; carbonyl functional groups; carbonyl reactive amine and/or hydrazine groups; alkoxy silane or SiOH groups; epoxy groups; mercapto groups; isothiocyanate groups; hydroxy groups, blocked isocyanate groups and ethylenically unsaturated groups. Preferably the molecular weight of component (iv) is in the range of from 150 to 4000 g/mol and more preferably in the range of from 200 to 2000 g/mol.

Preferably component (iv) comprises 15 to 60 wt.%, more preferably 20 to 50 wt.% of the isocyanate-terminated prepolymer.

Component (v) comprises polyols containing neither ionic or non-ionic water-dispersing groups, or crosslinker groups.

The polyols particularly include diols and triols and mixtures thereof but higher functionality polyols may be used, for example as minor components in admixture with diols. The polyols may be members of any of the chemical classes of polyols used or proposed to be used in polyurethane formulations. In particular the polyols may be polyesters, polyesteramides, polyethers, polythioethers, polycarbonates, polyacetals, polyolefins or polysiloxanes. Preferred molecular weights are from 600 to 4000, more preferably from 700 to 3000 g/mol. Preferably component (v) comprises 15 to 60 wt.%, more preferably 15 to 45 wt.% of the isocyanate-terminated prepolymer.

For component (vi) low molecular weight organic compounds containing at least one (preferably at least two) isocyanate-reactive groups and having a weight average molecular weight up to 500, preferably in the range of 40 to 250 can also be used. Examples include ethyleneglycol, di-ethylene glycol, tri-ethylene glycol, tetra-ethylene glycol and similarly poly-glycols made from propylene glycol up to a molecular weight of 500, neopentyl glycol; 1-propanol, bis(hydroxyethyl) teraphthalate, furan dimethanol, glycerol, 1,4-cyclohexyldimethanol and the reaction products of these examples with propylene and/or ethylene glycol up to a molecular weight of 500.

Preferably component (vi) comprises 0 to 40 wt.%, more preferably 0 to 30 wt.% of the isocyanate-terminated prepolymer.

The isocyanate-terminated polyurethane prepolymer is conventionally formed by reacting a stoichiometric excess of the organic polyisocyanate with the isocyanate-reactive compounds under substantially anhydrous conditions at a temperature between about 30°C and about 130°C until reaction between the isocyanate groups and the isocyanate-reactive groups is substantially complete; the reactants for the prepolymer are generally used in proportions corresponding to a ratio of isocyanate groups to

isocyanate-reactive groups of from about 1.2:1 to about 6:1, preferably from about 1.4:1 to 3:1.

If desired, catalysts such as dibutyltin dilaurate and stannous octoate, zirconium or titanium based catalysts may be used to assist the isocyanate-terminated prepolymer and/or polyurethane formation. An organic solvent may optionally be added before or after prepolymer formation or final polyurethane formation to control the viscosity.

Examples of solvents include water-miscible solvents such as N-methylpyrrolidone, dimethyl acetamide, glycol ethers such as butyldiglycol, methyl ethyl ketone and alkyl ethers of glycol acetates or mixtures thereof. The solvent may also include reactive diluents such as olefinically unsaturated monomers. Optionally no organic solvents are added.

An aqueous polyurethane composition may be prepared by dispersing isocyanate-terminated polyurethane prepolymer (optionally carried in an organic solvent medium) in an aqueous medium and chain extending the prepolymer with at least one active hydrogen-containing chain extender in the aqueous phase.

Active hydrogen-containing chain extenders which may be reacted with the isocyanate-terminated polyurethane prepolymer include amino-alcohols, primary or secondary diamines or polyamines, hydrazine, and substituted hydrazines.

Examples of such chain extenders useful herein include alkylene diamines such as ethylene diamine and cyclic amines such as isophorone diamine. Also materials such as hydrazine, azines such as acetone azine, substituted hydrazines such as, for example, dimethyl hydrazine, 1,6-hexamethylene-bis-hydrazine, carbodihydrazine, hydrazides of dicarboxylic acids and sulphonic acids such as adipic acid mono- or dihydrazide, oxalic acid dihydrazide, isophthalic acid dihydrazide, hydrazides made by reacting lactones with hydrazide such as gammahydroxylbutyric hydrazide, bis-semi-carbazide, and bis-hydrazide carbonic esters of glycols may be useful. Water itself may be effective as an indirect chain extender.

Where the chain extender is other than water, for example, a polyamine or hydrazine, it may be added to the aqueous dispersion of the isocyanate-terminated polyurethane prepolymer or, alternatively, it may already be present in the aqueous medium when the isocyanate-terminated polyurethane prepolymer is dispersed therein. The isocyanate-terminated polyurethane prepolymer may also be chain extended to form the polyurethane while dissolved in organic solvent (usually acetone) followed by the addition of water to the solution until water becomes the continuous phase and the subsequent removal of the solvent by distillation to form an aqueous dispersion.

The chain extension may be conducted at convenient temperatures from about 5°C to 95°C or, more preferably, from about 10°C to 60°C.

The total amount of chain extending active hydrogen compound employed (apart from water) should be such that the ratio of active hydrogens in the chain extender to

isocyanate groups in the polyurethane prepolymer preferably is in the range from 0.1:1 to 2.0:1 more preferably 0.80:1 to 1.7:1.

In another embodiment of the present invention there is provided a process for preparing an aqueous coating composition comprising the following steps:

- 5 a) reaction of components (i) to (v) to form an isocyanate-terminated prepolymer (A);
- b) forming an aqueous dispersion of the isocyanate-terminated prepolymer (A) in water;
- c) optionally neutralising the isocyanate-terminated prepolymer (A) after and/or during step a) and/or step b).
- 10 d) chain extension of the isocyanate-terminated prepolymer (A) by reaction with the active-hydrogen chain extending compound (B); and
- e) optionally adding cross-linker.

Surfactants and or high shear can be utilised in order to assist in the dispersion of isocyanate-terminated prepolymer or the polyurethane in water (even if it is self-dispersible). Suitable surfactants include but are not limited to conventional anionic, cationic and/or nonionic surfactants such as Na, K and  $\text{NH}_4$  salts of dialkylsulphosuccinates, Na, K and  $\text{NH}_4$  salts of sulphated oils, Na, K and  $\text{NH}_4$  salts of alkyl sulphonic acids, Na, K and  $\text{NH}_4$  alkyl sulphates, alkali metal salts of sulphonic acids; fatty alcohols, ethoxylated fatty acids and/or fatty amines, and Na, K and  $\text{NH}_4$  salts of fatty acids such as Na stearate and Na oleate. Other anionic surfactants include alkyl or (alk)aryl groups linked to sulphonic acid groups, sulphuric acid half ester groups (linked in turn to polyglycol ether groups), phosphonic acid groups, phosphoric acid analogues and phosphates or carboxylic acid groups. Cationic surfactants include alkyl or (alk)aryl groups linked to quaternary ammonium salt groups. Non-ionic surfactants include polyglycol ether compounds and polyethylene oxide compounds. The amount of surfactant used is preferably 0 to 15% by weight, more preferably 0 to 8% by weight, still more preferably 0 to 5% by weight, especially 0.1 to 3% by weight, and most especially 0.3 to 2% by weight based on the weight of the self-crosslinkable polyurethane.

The self-crosslinkable polyurethane has at least one glass transition temperature ( $T_g$ ) as measured by modulated differential scanning calorimetry (DSC), preferably being in the range of from  $-100$  to  $250^\circ\text{C}$ , more preferably  $-80$  to  $150^\circ\text{C}$  and most preferably  $-70$  to  $130^\circ\text{C}$  and especially  $-70$  to  $30^\circ\text{C}$ .

The self-crosslinkable polyurethane preferably has a particle size in the range of from 500 to 5000 nm, more preferably in the range of from 900 to 3500 nm and most preferably in the range of 1100 to 2500 nm.

Not wishing to be bound to this theory, however it appears that the larger the particle size, the greater the gloss reduction when compared with a conventional particle size of around 40 to 150 nm. However an increase in particle size may also result in a decrease in stability of the polyurethane when in a dispersed state.

In a further embodiment of the present invention if a reactive diluent is employed, in particular olefinically unsaturated monomers (also known as vinyl monomers) these may be polymerised in-situ to prepare a vinyl polymer.

Suitable vinyl monomers include but are not limited to (meth)acrylic acid, fumaric acid, itaconic acid, 1,3-butadiene, isoprene, styrene,  $\alpha$ -methyl styrene, divinyl benzene, indene, acrylonitrile, methacrylonitrile, vinyl halides such as vinyl chloride, vinyl esters such as vinyl acetate, vinylpropionate, vinyl laurate, vinyl esters of versatic acid, heterocyclic vinyl compounds, alkyl esters of mono-olefinically unsaturated dicarboxylic acids (such as di-n-butyl maleate and di-n-butyl fumarate) and, in particular, esters of (meth)acrylic acid of formula



wherein  $\text{R}^1$  is H or methyl and  $\text{R}^2$  is optionally substituted alkyl or cycloalkyl of 1 to 20 carbon atoms (more preferably 1 to 8 carbon atoms) examples of which are methyl (meth)acrylate, ethyl (meth)acrylate, trifluorethyl (meth)acrylate, n-butyl (meth)acrylate, 2-ethylhexyl (meth)acrylate, isopropyl (meth)acrylate, n-propyl (meth)acrylate, and hydroxyalkyl (meth)acrylates such as 2-hydroxyethyl (meth)acrylate, 2-hydroxypropyl (meth)acrylate and 4-hydroxybutyl (meth)acrylate.

All of the vinyl monomers may be present at the commencement of the preparation of the isocyanate-terminated prepolymer or some or all of the vinyl monomers may be added during the course of the preparation.

Preferably the vinyl monomers are not polymerised until after chain-extension has been carried out.

The polymerisation of any vinyl monomer will require the use of a free-radical-yielding initiator to initiate the vinyl polymerisation. Suitable free-radical-yielding initiators include inorganic peroxides such as ammonium persulphate hydrogen peroxide, organic peroxides, such as benzoyl peroxide, alkyl hydroperoxides such as t-butyl hydroperoxide and cumene hydroperoxide; dialkyl peroxides such as di-t-butyl peroxide; peroxy esters such as t-butyl perbenzoate and the like; mixtures may also be used. The peroxy compounds are in some cases advantageously used in combination with suitable reducing agents (redox systems) such as iso-ascorbic acid. Azo compounds such as azobisisobutyronitrile may also be used. Metal compounds such as Fe.EDTA (EDTA is ethylene diamine tetracetic acid) may also be usefully employed as part of the redox initiator system. The amount of initiator or initiator system to use is conventional, e.g. within the range of 0.05 to 6 wt.% based on the weight of vinyl monomer used.

Such an aqueous vinyl polymerisation normally would need to be performed in the presence of an external stabilising and/or dispersing material such as the surfactants discussed above and the amount used is usually 0.1 to 5% by weight based on the total vinyl monomer used.

The theoretical glass transition temperature, calculated using the Fox equation, of the resultant vinyl polymer may vary within a wide range, a preferred range being from -50 to 120°C, preferably from -20 to 80°C.

5 After polymerisation, the free vinyl monomer(s) content in the aqueous composition of the invention is preferably less than 500ppm, more preferably less than 300ppm, more preferably less than 100ppm.

~~If a reactive diluent, comprising vinyl monomers, is used the ratio of resultant vinyl~~  
polymer to self-crosslinkable polyurethane is preferably in a weight ratio in the range of from 10:90 to 90:10, more preferably 20:80 to 60:40 and most preferably 30:70 to 50:50.

10 The aqueous composition of the present invention typically has a solids content of from about 20 to 60% by weight, more preferably from 25 to 55% by weight.

The aqueous composition of the present invention may contain other conventional ingredients including coalescing organic solvents, pigments, dyes, emulsifiers, surfactants, thickeners, heat stabilisers, levelling agents, anti-cratering agents, fillers, sedimentation inhibitors, UV absorbers, antioxidants and the like introduced at any stage  
15 of the preparation process or subsequently. It is possible to include an amount of antimony oxide in the dispersions to enhance the fire retardant properties. Preferably the aqueous composition of the invention contains  $\leq 6\%$  by weight of flattening agent, more preferably  $\leq 5\%$ , most preferably  $\leq 4\%$ , especially  $\leq 2\%$ , more especially  $\leq 1\%$  and most  
20 especially contains in the range of from 0 to 0.5 wt % of flattening agent by weight of the self-crosslinkable polyurethane. Typically a flattening agent when added at 5% by weight of the self-crosslinkable polyurethane reduces the gloss at 60° by  $\geq 30\%$ .

In particular the aqueous composition of the invention if comprising autoxidisable groups on the self-crosslinkable polyurethane advantageously includes at least a drier salt. Drier salts are well known to the art for further enhancing autoxidation in unsaturated fatty acid residue containing film-forming substances. Generally speaking, drier salts are  
25 metallic soaps, that is salts of metals and long chain carboxylic acids or metal naphthanates. It is thought that the metallic ions effect the curing action in the film coating and the fatty acid components confer compatibility in the coating medium. The most important drier metals are cobalt, manganese, zirconium, lead and calcium. The level of drier salt in the composition is typically that to provide an amount of metal within  
30 the range of from 0.01 to 0.5% by weight based on the weight of the self-crosslinkable polyurethane.

Drier salts are conventionally supplied as solutions in common organic solvents.  
35 They may, however, be used quite satisfactorily in aqueous coating composition since they can normally be dispersed in such systems fairly easily. The drier salt may be incorporated into the composition at any convenient stage.

Other useful ingredients in the aqueous composition include rheology modifiers and urethane associative thickeners such as hydrophobe-modified ethylene oxide urethane (HEUR) which provides stabilisation and modifies the rheology by acting as a  
40

thickener. A potential disadvantage of such materials (HEUR) however is that they may contribute to water-sensitivity in the final coating.

Thus in a further embodiment of the present invention there is provided an aqueous coating composition comprising:

- I) 40 to 80 wt %, preferably 50 to 70 wt % of water;
- II) 0 to 30 wt %, preferably 0 to 20 wt % of co-solvent;
- III) 20 to 60 wt %, preferably 30 to 50 wt % of the self-crosslinkable polyurethane;
- IV) 0 to 10 wt %, preferably 0 to 7 wt % of hydrophobe modified ethylene oxide urethane;
- V) 0 to 16 wt %, preferably 0 to 10 wt %, more preferably 0 to 5 wt % of surfactants;
- VI) 0 to 10 wt %, preferably 0.5 to 4 wt % of thickeners; and
- VII) 0 to 3 wt %, preferably 0 to 1 wt % of alkyd drying agent, accelerator and or activator;

where I), II), III), IV), V), VI) and VII) add up to 100%.

The aqueous coating composition of the present invention is particularly useful as a coating composition or for providing the principle component of coating compositions (e.g. protective or decorative coating compositions) for which purpose they may be further diluted with water and/or organic solvents, or they may be supplied in more concentrated form by evaporation of water and/or organic components of the liquid medium. As coating compositions, they may be applied to a variety of substrates including, wood, board, metal, stone, concrete, glass, cloth, leather, paper, plastics, foam and the like, by conventional methods including brushing, dipping, flow coating, spraying, and the like. They are, however, particularly useful for providing coatings on wood and board substrates. The aqueous liquid medium usually comprising water and any co-solvent is removed by natural or accelerated (by heat) drying to form a coating.

There is further provided according to the present invention a coating obtained from an aqueous composition according to the present invention.

There is also provided a coated substrate having a coating comprising an aqueous coating composition according to the present invention; and a method for coating a substrate using an aqueous coating composition according to the present invention comprising a) application of the aqueous coating composition to the substrate and b) removal of the water and any co-solvent.

The present invention is now illustrated by reference to the following example. Unless otherwise specified, all parts, percentages and ratios are on a weight basis. The prefix C before an example denotes that it is comparative.

ExamplesAbbreviations used

Millester 9-55	Hexane diol-neopentyl glycol adipate polyester polyol available from Polyurethane Specialties Company Inc
U7380	Proprietary alkyd diol available from NeoResins Inc
DMPA	Dimethylol propionic acid
DC 1248 fluid	Polyhydroxyl polydimethylsiloxane polyol/polymer available from Dow Corning
NMP	N-methyl pyrrolidone
IPDI	Isophorone diisocyanate
F-820	Di-butyl tin dilaureate catalyst available from Ferro Corporation
Desmodur N-3200	A polyisocyanate based on the biuret of hexamethylene diisocyanate available from Bayer
TEA	Triethyl amine
H <sub>2</sub> O	Deionised water
DSX-1514	A proprietary urethane associative thickener available from Henkel Corporation
Triton X-405	A proprietary non-ionic surfactant available from Union Carbide/Dow
Dapro 7007	Catalyst/accelerator for alkyd cure available from Elementis Specialties
NeoRez R-9403	A uralkyd dispersion available from NeoResins Inc
N <sub>2</sub> H <sub>4</sub> (64%)	Hydrated hydrazine solution available from Aldrich Co
NCO	Isocyanate group
OH	Hydroxyl group
NeoRez R-9637	Commercially available polyurethane dispersion from NeoResins Inc
SLS	Sodium Lauryl Sulphonate available from Rhodia as Rhodapon SB-8208/5
Silica	TS 100 available from Degussa

5

Example 1 and Example 2

The components used to prepare the isocyanate terminated prepolymer are listed in Table 1 below and to prepare the aqueous composition of the invention are listed in Table 2 below.

Table 1

Item No.	Material	Example 1		Example 2	
		Wt (g)	Wt %	Wg (g)	Wt (%)
1	Millester 9-55	109	29.2	109	27.6
2	U7380	109	29.2	109	27.6
3	DMPA	8.7	2.3	8.7	2.2
4	DC 1248 fluid	20	5.3	20	5
5	NMP	34	-	34	-
6	IPDI	106	28.4	106	26.8
7	F-820	0.2	-	0.2	-
8	Desmodur N-3200	21	5.6	42	10.6
9	TEA	10.5	-	10.5	10.5
prepolymer (Items 1-7) NCO:OH ratio		2.0		2.0	
Theoretical NCO% (prior to adding items 8 & 9)		5.18%		5.18%	
Theoretical final adjusted NCO% (after adding items 8 & 9)		5.95%		6.78%	

5

Table 2

		Example 1	Example 2
Item No.	Material	Wt (g)	Wt (g)
10	H <sub>2</sub> O	520	520
11	DSX-1514	9.2	2
12(a)	Triton X-405	6.2	7.2
12(b)	SLS	-	1
13	Dapro 7007	2	2
14	R9403	116	116
15	Prepolymer	320	320
16	N <sub>2</sub> H <sub>4</sub> (64%)	8.6	8.6



ProcedureStage 1:

5 The isocyanate-terminated prepolymer is prepared in the following manner. Items 1 to 5 were loaded into the reactor and the temperature adjusted to 55 to 60°C while stirring/mixing was applied. At 55 to 60°C item 6 was loaded into the reactor containing items 1 to 5 and the temperature adjusted to 80 to 82°C and held for 45 minutes at which  
10 ~~time item 7 was then added. The reaction was allowed to proceed for an additional 1.75~~ hours at 80 to 82°C, or until the theoretical NCO% was reached (as determined by a wet analysis of the prepolymer). (Typically the actual NCO% when the prepolymer is "finished" is 92 to 98% of theoretical when measured by wet analysis). After reaching the theoretical NCO% the prepolymer cooling was started to bring the temperature of the prepolymer to 68 to 70°C. During this cooling process item 8 was added to the prepolymer reactor and homogenised with stirring. When the prepolymer reached 68 to 70°C item 9 was added to the prepolymer and homogenised with mixing. Items 10 to 14  
15 were placed in a dispersion vessel sequentially and homogenised with adequate stirring and the temperature adjusted to 18 to 20°C. The prepolymer (item 15) was then dispersed into the homogenised mixture adjusting the stir/shear rate to improve dispersing of the prepolymer if necessary while maintaining the temperature at  $\leq 28^\circ\text{C}$ . After the given amount of prepolymer was dispersed stirring was continued for an additional 3 to 5  
20 minutes after which item 16 was added to the dispersion to provide the chain extended self-crosslinkable polyurethane. Item 16 was allowed to react with stirring over a period of 45 to 60 minutes before the polyurethane was then packaged. The final dispersion of Examples 1 and 2 typically had a solids level of about 31%, a viscosity of 300 to 700 cps and a pH of 7.5 to 8.5.

25 The particle size of the resultant self-crosslinkable polyurethane in Examples 1 and 2 was 1000 to 2000 nm.

Gloss Measurements

30 Gloss measurements were carried out on a BYK Gardner micro-TRI-gloss 20-60-85 glossmeter in accordance with ASTM D523-89, the results are shown in Table 3 below, and confirm that the use of sufficient flattening agent to obtain low gloss values in conventional systems such as R9637 lead to a lack of stability and ease of handling of the composition, when compared with the composition of the present invention.

Table 3

	<u>60° Gloss</u>	<u>85° Gloss</u>	<u>Stability</u>
R9637	90.6	98.6	✓
R9637 + 5% silica	10.9	30.5	✓
R9637 + 25% silica	7.7	41.1	x
Example 1	1.0	34.2	✓
Example 2	1.1	3.1	✓

CLAIMS

1. An aqueous coating composition having a 60° gloss of  $\leq 40$  upon drying comprising a self-crosslinkable polyurethane obtained by the reaction of:

- 5 (A) an isocyanate-terminated pre-polymer formed from components which comprise
- (i) 5 to 65 wt% of at least one organic polyisocyanate;
  - (ii) 0.1 to 6 wt% of at least one polyol containing ionic or potentially ionic  
10 water-dispersing groups, having two or more isocyanate-reactive groups and  
having a molecular weight in the range of from 100 up to 500 g/mol;
  - (iii) 0 to 30 wt% of at least one polyol containing water-dispersing groups,  
15 having two or more isocyanate-reactive groups and having a molecular weight in  
the range of from 500 to 6000 g/mol;
  - (iv) 10 to 80 wt% of at least one polyol containing crosslinkable groups, having  
two or more isocyanate-reactive groups and having a molecular weight in the  
20 range of from 150 to 6000 g/mol;
  - (v) 10 to 70 wt% of at least one polyol not comprised by (ii) or (iii) having two  
or more isocyanate-reactive groups and having a molecular weight in the range of  
from 500 to 6000 g/mol;
  - (vi) 0 to 50 wt% of at least one component not comprised by (i), (ii), (iii), (iv) or (v);  
where (i), (ii), (iii), (iv), (v) and (vi) add up to 100 wt%; and  
where the NCO:OH ratio is in the range of from 1.1 : 1.0 to 10.0 : 1.0; and

(B) at least one active-hydrogen chain extending compound.

25 2. An aqueous coating composition according to claim 1 having a 60° gloss of  $\leq 30$ .

3. An aqueous coating composition according to any one of the preceding claims  
10 additionally comprising component (ia) 0 to 20 wt% of at least one organic polyisocyanate  
with an isocyanate functionality  $\geq 2.2$ , where (i), (ii), (iii), (iv), (v), (vi) + (ia) add up to 100  
wt%.

4. An aqueous coating composition according to any one of the preceding claims  
5 wherein the active-hydrogen chain extending compound is selected from the group  
comprising water, amino-alcohols, primary or secondary diamines or polyamines,  
hydrazine, substituted hydrazines and substituted hydrazides.

5. An aqueous coating composition according to any one of the preceding claims  
wherein the water-dispersing groups of component (iii) are non ionic water-dispersing  
groups.

6. An aqueous coating composition according to any one of the preceding claims wherein the water-dispersing groups are anionic or potentially anionic water-dispersing groups.

7. An aqueous coating composition according to any one of the preceding claims wherein component (vi) comprises a diol having a molecular weight of 40 to 500 g/mol.

8. An aqueous coating composition according to any one of the preceding claims wherein component (vi) comprises a polysiloxane polyol.

9. An aqueous coating composition according to any one of the preceding claims wherein component (iv) has self-crosslinkable groups selected from ethylenically unsaturated groups, carbonyl functional groups, alkoxysilane groups, epoxy groups, amino groups, mercapto groups, isothiocyanate groups and hydrazine groups.

10. An aqueous coating composition according to any one of the preceding claims which additionally comprises at least one post-added crosslinker in the range from 0 to 35 wt% based on solids of the self-crosslinkable polyurethane.

11. An aqueous coating composition according to any one of the preceding claims having a solids content of from about 20 to 60% by weight.

12. An aqueous coating composition according to any one of the preceding claims wherein the self-crosslinkable polyurethane has an average particle size in the range of from 500nm to 5000nm.

13. An aqueous coating composition according to any one of the preceding claims additionally comprising a reactive diluent.

14. An aqueous coating composition according to claim 13 wherein the reactive diluent comprises olefinically unsaturated monomer(s).

15. An aqueous coating composition according to claim 14 wherein the olefinically unsaturated monomer(s) are selected from at least one member of the group containing free acids, esters of (meth)acrylic acid, hydroxy alkyl (meth)acrylates and styrene.

16. An aqueous coating composition according to any one of the preceding claims comprising:

- I) 40 to 80 wt % of water;
- II) 0 to 30 wt % of co-solvent;

- III) 20 to 60 wt % of the self-crosslinkable polyurethane;  
IV) 0 to 10 wt % of hydrophobe modified ethylene oxide urethane;  
V) 0 to 16 wt % of surfactants;  
VI) 0 to 10 wt % of thickeners; and  
5 VII) 0 to 3 wt % of alkyd drying agent, accelerator and or activator;  
where I), II), III), IV), V), VI) and VII) add up to 100%.
- 

17. A process for preparing an aqueous coating composition according to any one of the preceding claims comprising the following steps:

- 10 f) reaction of components (i) to (v) to form an isocyanate-terminated prepolymer (A);  
g) forming an aqueous dispersion of the isocyanate-terminated prepolymer (A) in water;  
h) optionally neutralising the isocyanate-terminated prepolymer (A) after and/or during step a) and/or step b).  
15 i) chain extension of the isocyanate-terminated prepolymer (A) by reaction with the active-hydrogen chain extending compound (B); and  
j) optionally adding cross-linker.

18. A process according to claim 17 additionally comprising the addition and subsequent polymerisation of a reactive diluent.

19. A coating obtained from an aqueous coating composition according to any one of claims 1 to 16.

20. A coated substrate having a coating comprising an aqueous coating composition according to any one of claims 1 to 16.

21. A method of coating a substrate using an aqueous coating composition according to any one of claims 1 to 16, comprising (a) application of the aqueous coating composition to a substrate and (b) removal of the water and any co-solvent.

PCT Application  
**GB0305465**

